Reducing gender bias against women in STEM through self-affirmation and persuasive arguments

Senior Research Thesis

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By

Rita Knasel

The Ohio State University

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Defense Committee:

Dr. Steven J. Spencer, Department of Psychology (Advisor)

Dr. Kristy Boyce, Department of Psychology

Abstract

As women continue to be highly underrepresented in science, technology, engineering, and mathematics (STEM) fields, there is a need for research on potential solutions to this gender gap. Although a number of studies have provided insights into such potential solutions, most of them have examined interventions designed to help women cope with the *effects* of stereotype threat. Relatively few studies have examined interventions designed to addresses the *source* stereotype threat. Previous research suggests that one source of stereotype threat for women in STEM is biased beliefs and behaviors of *men* in STEM (Logel et al., 2009) Thus, the present research examines a novel intervention to reduce men's biases towards women in STEM. To do this, I used a combination of self-affirmation (i.e. reflecting on core values) and a strong persuasive appeal which challenge negative beliefs about women in STEM, in a 2 (self-affirmation vs. control) 2×2 (persuasive appeal vs. control article) between participants design. We recruited sixty-eight undergraduate male participants. Among those with high pre-intervention stereotype endorsement, the persuasive appeal was only effective if the participant had also been self-affirmed. It was not successful in reducing stereotype endorsement among non-affirmed participants. The discussion focuses on implications of these findings for reducing gender bias in STEM.

Introduction

Although women are increasingly entering many traditionally male-dominated fields (e.g. medicine, law, etc.), they remain underrepresented in STEM (science, technology, engineering, and math). For instance, according to one recent report, women receive only thirty-five percent of STEM baccalaureate degrees in the United States, where as men receive the remaining sixty-five percent of degrees (National Center for Education Statistics, 2017). Additionally, according to the US Census Bureau, women hold only twenty-six percent of STEM-related occupations while men hold seventy-four percent of STEM occupations (Landivar, 2013). Why are women so highly underrepresented in STEM domains?

One possible answer to this question is the negative stereotype that men are superior to women in math and science. This stereotype affects women in a number of ways across many different stages in life. For instance, gender differences in interest in math and science are observed as early as elementary school (Ceci & Williams, 2010). At the beginning stages of their education, young girls begin to discover which subjects in school they are interested in and which ones they are not. When girls become aware of the stereotype that men are better at math and science, they often become less interested in those domains and less likely to try them in the first place (Master, Cheryan, Moscatelli, & Meltzoff, 2017; Walton & Cohen, 2007). This effect has been shown to continue on into higher education. Indeed, one study found that stereotypes and ambient identity cues, or objects that communicate stereotypical information about group members, can deter women from entering STEM environments (Cheryan, Plaut, Davies, & Steele, 2009).

When women and girls do enter STEM settings, they face additional obstacles. For instance, because women are so highly underrepresented in STEM fields, women have far fewer role models compared to the men in STEM (Herrmann, Adelman, Bodford, Graudejus, Okun, & Kwan, 2016). In addition, women may face *stereotype threat* in STEM fields, that is, the concern that one's behavior could confirm negative stereotypes about one's social group (e.g. their race or their gender; Steele 1997*)*. Suppressing negative stereotypes about one's group uses up cognitive recourses critical for solving problems commonly found on STEM assessments (Schmader, Johns, & Forbes, 2008). Consequently, woman in STEM classrooms experiencing stereotype threat and suppressing negative stereotypes often perform below their abilities on STEM assessments (Logel, Davies, Iserman, Quinn, & Spencer, 2009). Therefore, STEM assessments taken under typical classroom conditions often underestimate their *latent,* or true, ability (Walton & Spencer, 2009).

Negatively stereotyped groups are particularly likely to experience stereotype threat in environments in which subtle contextual cues communicate that the negative stereotype is relevant in that setting (Murphy, Steele, & Gross, 2007). People gain valuable information about the way they are viewed and judged by others through the interactions that they have with other people (Logel, Walton, Spencer, Iserman, Von Hippel, & Bell, 2009). These interactions can also play a crucial role in the effects of stereotype threat. More specifically, previous research has shown women experience more stereotype threat when they encounter men with sexist attitudes. For instance, in one study researchers measured sexism in male engineering students and then instructed them to interact with a female confederate. Men who held more sexist attitudes exhibited more sexist and disrespectful behaviors towards the female confederate (Logel et al., 2009). In an additional study, female engineering students then interacted with a male confederate who behaved either in a sexist, disrespectful manner or in neutral manner. When the confederate behaved in a sexist manner, the women with whom he interacted performed worse on a subsequent math assessment. This research suggests that men who hold sexist attitudes often convey these attitudes through behavioral cues, which create a negative, discouraging environment for their female peers (Logel et al., 2009).

Given that stereotype threat can undermine women's outcomes in STEM, an important question to investigate is: How can the negative effects of stereotype threat be reduced? Recent research has begun to answer this question by examining interventions to mitigate the effects of stereotype threat for women in STEM (Walton & Wilson, 2018). Many of these interventions have sought to reduce stereotype threat by changing women's *mindsets* about their STEM experiences – that is, to change women's construals of potentially threatening experiences in STEM. For instance, in one study, female engineering students received an intervention that encouraged them to view their difficulties as common and temporary (Walton, Logel, Peach, Spencer, & Zanna, 2015). Women who received this intervention reported higher engineering GPAs as well as more positive attitudes towards engineering than those that did not. Other examples of these types of interventions include thought replacement (Logel et al., 2009), self-affirmation (Miyake, Kost-Smith, Finkelstein, Pollock, Cohen, & Ito, 2010), and growth mindset training (Good, Aronson, Inzlicht, & 2003; Paunesku, Walton, Romero, Smith, Yeager, & Dweck, 2015). Although these methods are effective tools for women to use to combat stereotype threat, they all seek to help women cope with stereotype threat. Given the research that shows that sexist men can trigger feelings of stereotype threat in women (Logel et al., 2009), a more preemptive intervention that focuses on removing the *source* of stereotype threat might be more useful.

One possible way to do so is by changing the sexist and disrespectful attitudes some men hold towards women, rather than attempting to mitigate the consequences of these attitudes.

Some recent research has begun to examine this possibility (Litt et al., 2016). In this work, the researchers utilized Bandura's social learning theory in which people learn certain behaviors by observing the behaviors of others (Bandura & Walters, 1977). Specifically, male engineering students watched an interaction between one male and one female engineering teaching assistant (TA). In the interaction, the male engineering TA modeled respectful behaviors such as letting the female TA speak first, having appropriate body posture and proximity in relation to her, and thanking her for her help and expertise. Following the video, male participants were grouped together with a single female participant and instructed to complete an engineering task together. Men who received this intervention exhibited more positive and respectful attitudes towards the female they interacted with. The effects of this intervention, however, did not extend to attitudes towards female engineers as an entire group, rather it affected only their behaviors toward the female with whom they had direct contact.

Thus, the present research tests an intervention designed to change men's attitudes towards women in STEM more generally. According to the elaboration likelihood model of persuasion, using a strong persuasive appeal could be a plausible approach to change beliefs and attitudes men hold towards women in STEM (Petty, Cacioppo, 1986). Specifically, research suggests that strong persuasive appeals that are logical, contain explicit, evidence-based arguments, and come from credible sources are the most effective in producing attitude change (Leippe & Elkin, 1987; Hovland, Lumsdaine & Sheffield, 1949; Petty & Briñol, 2010; Petty, Cacioppo, & Goldman, 1981). Thus, the present research aims to design a persuasive appeal with each of these characteristics to most effectively change men's attitudes towards women in STEM.

Additional research, however, has shown that information that is counter to one's existing beliefs and attitudes can threaten one's self-image and is often subject to biased and defensive processing and evaluation (Sherman & Cohen, 2006). For men, a persuasive appeal that challenges negative stereotypes about women in STEM could be perceived as threatening and may result in defensive processing, particularly for those who strongly endorse these negative stereotypes. A persuasive appeal alone may therefore be insufficient to change men's attitudes and beliefs. Self-affirmation, or reflecting on core values (e.g. religion, family, art, music, helping others), allows for more objective processing of threatening information (Sherman & Cohen, 2006; Correll, Spencer, & Zanna, 2004). For instance, in one study students heard strong and weak arguments for a tuition increase at their university (a position that would presumably be counter-attitudinal for most undergraduates). When they had not affirmed an important value they were only persuaded by pro-attitudinal arguments (i.e. arguments against a tuition increase), even if the arguments in favor of a tuition increase were strong. When they affirmed an important value, however, they were persuaded by strong arguments (and not weak arguments) regardless of whether the arguments supported or opposed a tuition increase (Correll et al., 2004). This study suggests that self-affirmation can allow people to more objectively evaluate information, even if it is counter to their existing beliefs.

Following from this reasoning, the present research attempts to utilize the effects of self-affirmation and strong persuasive appeals to persuade men to have more positive, respectful beliefs and attitudes towards women in STEM. Based on previous research (Correll et al., 2004), we hypothesize that affirmed participants will be more sensitive to a strong persuasive appeal, and will therefore show more positive changes in their beliefs and attitudes towards women in STEM in response to a persuasive appeal. Furthermore, we hypothesize that the effects of a persuasive appeal and self-affirmation should be stronger among men who strongly endorse negative stereotypes about women in STEM, as a persuasive appeal would likely be particularly threatening in this group. The present study uses a 2(self-affirmation vs. control) × 2 (persuasive appeal vs. control) between-subjects design to test the effects of both the evidence-based persuasive appeal and self-affirmation on men's beliefs and attitudes towards women in STEM.

Methods

Participants

To recruit participants, we posted the study on the university's Research Experience Program (REP) webpage for Psychology 1100 students and posted flyers advertising the study in lecture halls, dorms and libraries throughout campus. The flyers and study postings explained that we were investigating how students evaluate scientific information and how that relates to interpersonal processes and beliefs. A total of 68 male undergraduates participated in the study.

Procedure

Prior to coming into the lab to participate, participants completed an online pre-intervention survey, which included measures of ambivalent sexism (Glick & Fiske, 1996) and stereotype endorsement (Ramsey, Betz, & Sekaquaptewa, 2013). After participants completed the pre-intervention survey, they then came into the lab to participate in the lab portion of the study. Once participants arrived in the lab, the experimenter informed them that they would be completing two ostensibly separate studies. They were then told that the first study was about different values students hold, and that the second study was about how people evaluate scientific articles. The ostensible first study consisted of a self-affirmation manipulation, in which students were asked to complete a self-affirmation writing exercise or a control exercise. The ostensible second study consisted of an evidence-based persuasive appeal manipulation, in which students read either an article about women's abilities in STEM or an article about a neutral topic. Finally, participants completed a post-intervention survey.

Self-Affirmation Manipulation. Participants were randomly assigned to complete either a self-affirmation exercise or a control exercise, following procedures from previous research (Sherman & Cohen, 2006). In the self-affirmation condition, we instructed participants to choose their most important value from a list of six values (e.g. religious values, relationship with family and friends). They were then instructed to write about why that value is important to them. In the control condition, participants were instructed to pick the value that was least important to them from the same list of values and then write about why that value might be important for someone else.

Evidence-Based Persuasive Appeal Manipulation. After the self-affirmation manipulation, participants read either the evidence-based persuasive appeal article, or a control article about plants. The persuasive appeal article was edited to appear as if it was written by the National Academy of Science and discussed two main ideas: First, gender disparities in STEM and second, that gender disparities in STEM are due to social barriers women encounter rather than their lack of abilities. It therefore challenges cultural stereotypes that women are less capable in STEM fields than men. The article introduces the issue of gender disparities in STEM by citing the example of Donna Strickland, the Nobel prize winning physicist who "had never been promoted to full professor at her university and who made less than the median annual salary," despite her superior credentials and abilities. The article then mentions that girls actually outperform boys in math and science throughout grades K-12, citing Else-Quest, Hyde, & Linn (2010). It also states that even though girls perform worse than boys on high-stakes math tests, these differences are due to negative stereotypes about girls. It further states that "college admissions tests underestimate the future performance of girls and overestimate the future performance of boys" and summarizes from analyses from Walton and Spencer (2009), Fischer, Schult, & Hell (2013), and Spelke (2005) showing that there is "little evidence for boys being better at mathematics than girls." Additionally, the article states that women avoid STEM fields not because they lack the ability to succeed, but because of the "chilly climate" that exists in STEM fields. For example, the article states, "This 'chilly climate' is characterized by explicit and implicit gender biases, negative stereotypes, and a variety of subtle cues that make women feel unwelcome and unworthy in STEM (Cheryan et al. 2009)". The article ends on a powerful concluding statement, "Overall, the evidence is clear: although a number of social barriers have deterred women from STEM fields, women and men are equally capable of succeeding in STEM" (see Appendix A for the full article).

Measures

Perceptions of the article. To access participants' defensiveness towards the persuasive article, we included six items on participants' perceptions of the article, drawn from previous research (Updegraff, Sherman, Luyster, & Mann, 2007). These included: "How compelling did you find the evidence cited in this article?" and "How scientific was the research described in the article?". These items were rated on a five-point scale (1= *not at all* to 5 *extremely).*

Stereotype Endorsement. The stereotype endorsement measure consisted of four items (e.g. "According to my own personal beliefs, I generally expect men to do better at math than women"). Responses to the items were also rated on a seven-point Likert scale (1= *strongly disagree* to 7= *strongly agree).*

Ambivalent Sexism. Our measure of ambivalent sexism consisted of twelve items adapted from previous research (Glick & Fiske, 1996) to be specific to the STEM domain. The ambivalent sexism scale includes items related to both hostile sexism and benevolent sexism (Glick & Fiske, 1996). Examples of items related to hostile sexism include, “Female STEM students seek to gain power by getting control over men” and “Many female STEM classmates are actually seeking special favors, such as scholarships or co-op jobs that favor them over male classmates, under the guise of asking for "equality". Examples of items related to benevolent sexism include, “Male STEM students should go out of their way to help their female classmates with course work” and “In order to do well in STEM, female classmates need extra academic support compared to men”. Responses to these items were rated on a seven-point Likert scale (1= *strongly disagree* to 7= *strongly agree)*. See Appendix B for a complete list of questions for dependent variables.

Results

To analyze the effects of our manipulations on the dependent variables, we conducted a series of regression models using the Process macro (Hayes, 2012) to test for a three-way interaction between persuasive-appeal condition, self-affirmation condition, and pre-intervention stereotype endorsement. Self-affirmation condition and persuasive appeal condition were both effect coded (-1 = control affirmation condition/ control article condition; 1 = self-affirmation condition/ persuasive appeal condition) and pre-intervention stereotype endorsement was mean-centered.

Article Perception

For perceptions of the article, the three-way interaction between persuasive appeal condition, self-affirmation condition, and pre-intervention endorsement of stereotypes was non-significant, $\beta = 0.0003$, $t(59) = 0.0043$, $p = 0.997$. In addition, the main effects of self-affirmation condition, article condition, and pre-intervention endorsement of stereotypes, as well as the two-way interactions between these variables, were all non-significant (*ps* > 0.15).

Post-Intervention Stereotype Endorsement

The main effects of persuasive appeal condition and self-affirmation condition on post-intervention stereotype endorsement were both non-significant (ME persuasive appeal condition: $\beta = -0.18$, $t(59) = -1.62$, $p = 0.11$; ME self-affirmation condition: $\beta = -0.10$, $t(59) = -0.95$, $p = 0.37$). Pre-intervention endorsement of stereotypes significantly predicted post-intervention endorsement of stereotypes, $\beta = 0.86$, $t(59) = 11.4$, $p < 0.001$. Our main interest, however, was in the three-way interaction between persuasive appeal condition, self-affirmation condition, and pre-intervention stereotypes. Consistent with our predictions, there was a significant three-way interaction between these variables, $\beta = -0.18$, $t(59) = -2.46$, $p = 0.017$.

Among participants who reported *higher* pre-intervention stereotype endorsement (+1 SD), there was a significant two-way interaction between persuasive appeal condition and self-affirmation condition $F(1, 59) = 4.035$, $p = 0.049$. Within this group of participants, those in the persuasive appeal condition showed reduced post-intervention stereotype endorsement relative to those in the control article condition only when they were also in the self-affirmation condition, $\beta = -0.41$, $t(59) = -2.18$, $p = 0.034$. Among those who received the control affirmation condition, the effect of persuasive appeal condition was non-significant, $\beta = 0.25$, $t(59) = 0.93$, $p = 0.36$ (see Appendix C, Figure 1 for visual representation of this interaction).

Among people who reported *lower* pre-intervention stereotype endorsement (-1 SD), the two-way interaction between persuasive appeal condition and self-affirmation condition was non-significant, $F(1, 59) = 2.34$, $p = 0.13$. Among those in the control affirmation condition, the persuasive appeal article condition led to lower post-intervention stereotype endorsement,

β = -0.49, $t(59)$ = -2.15, p = 0.035. For those in the self-affirmation condition, the effect of persuasive appeal condition was non-significant, β = -0.045, $t(59)$ = -0.25, p = 0.80 (see Appendix C, Figure 2 for visual representation of this interaction).

Benevolent Sexism

Pre-intervention stereotype endorsement significantly predicated benevolent sexism, β = 0.36, $t(59)$ = 3.53, p = 0.0008. However, the three-way interaction between persuasive appeal condition, self-affirmation condition, and pre-intervention stereotype endorsement, as well as the two-way interactions between these variables and their main effects, were all non-significant (*ps* > 0.38).

Hostile Sexism

As above, pre-intervention stereotype endorsement significantly predicated hostile sexism, β = 0.24, $t(59)$ = 2.30, p = 0.025. Again, the three-way interaction between persuasive appeal condition, self-affirmation condition, and pre-intervention stereotype endorsement, as well as the two-way interactions between these variables and their main effects, were all non-significant (*ps* > 0.11).

Discussion

This study investigated a novel intervention to change men's beliefs about women in STEM. To do this, we used a combination of self-affirmation, which was designed to reduce defensiveness and increase open-mindedness, and a persuasive appeal, which utilized strong arguments to challenge negative stereotypes about women in STEM. We examined the effects of this intervention on defensive responses to the persuasive appeal, endorsement of stereotypes about women in STEM, and benevolent and hostile sexism towards women in STEM. We predicted that those who received both the self-affirmation intervention and the persuasive-appeal would report less sexist attitudes and beliefs following the intervention. Furthermore, we predicted that the effects of the two interventions would be stronger among men who reported greater endorsement of negative stereotypes about women in STEM at baseline, because the persuasive appeal would presumably be the most threatening for this population of people. Thus, we predicted that the self-affirmation intervention would be critical in buffering against defensive processing and allow for a more open-minded evaluation of the information in the persuasive appeal.

As expected, for those who reported high levels of pre-intervention stereotype endorsement, the persuasive appeal was only effective in reducing stereotype endorsement if they had been self-affirmed. Additionally, among non-affirmed participants, those with high pre-intervention stereotype endorsement who received the persuasive appeal showed an increase in stereotype endorsement compared to those in control condition, though this difference was not statistically significant.

Unexpectedly, among participants who reported low levels of pre-intervention stereotype endorsement, the persuasive appeal reduced post-intervention stereotype endorsement, but only when participants had *not* been self-affirmed. We would have expected that for those who already endorsed more egalitarian views, their beliefs would not have changed in response to the persuasive appeal as they would already agree with that statements being made in the article. If their attitudes did change as result of the persuasive appeal, we would expect them to also change in the affirmation condition as well.

It is important to note that benevolent and hostile sexism were not affected by the interventions. Instead these variables were highly predicted by pre-intervention measures. This suggests that these variables are more stable individual differences that were not affected by the manipulation. It is possible that even though the interventions affected *beliefs* about women in STEM, which were more directly targeted in the persuasive appeal, the effects did not extend to more general *attitudes* about women in STEM.

There are a number of limitations that should be considered. First, our limited sample size resulted in the study being statistically underpowered. This lack of power could have hindered our ability to detect significant effects of the intervention for some of our dependent variables. Additionally, the limited sample size could also potentially account for the unexpected significant effects seen on post-intervention stereotype endorsement in the low pre-intervention stereotype endorsement group. Indeed, small sample sizes can increase the risk of both type II errors and type I errors in research (Button et al., 2013). Therefore, future research should attempt to replicate the present study with a larger sample size.

A second limitation is that the present research examined only endorsement of stereotypes and sexist attitudes. It is unclear whether the effects of the intervention would persist over time and whether the intervention would affect men's behaviors towards women. To the extent that the intervention leads men to behave in more respectful ways towards women in STEM, it could reduce experiences of social identity threat for women in STEM. Thus, future studies should examine how such an intervention would impact men's beliefs and attitudes over time, as well as their behaviors towards women.

The present research has implications for the literature on strategies to reduce social identity threat among women in STEM. In particular, this work suggests that men who endorse stereotypic content react defensively to information that challenges those preexisting beliefs. If they can be self-affirmed, it may be easier to persuade them to change their beliefs about women in STEM. In the future, if the limitations of this study are addressed and this intervention proves to be an effective way of reducing men's gender bias against women in STEM, additional studies should examine whether changing men's attitudes would also change their behaviors towards women in STEM and if that then would in turn improve women's experience's in STEM.

Conclusion

The dearth of women in STEM fields is a major issue in our society. Additional intervention research will be essential in the efforts to close the extensive gender gap. Research which aims to change their male peers' attitudes could be an important first step in creating a welcoming, identity safe environment for women, an environment in which they feel they can learn and work free of judgment.

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APPENDIX A

Persuasive Appeal Article

In 2018, Donna Strickland won the Nobel Prize for Physics—the first woman to win in 55 years. Despite her clear accomplishments, she had never been promoted to Full Professor at her university and made less than the median annual salary in her department (and she is the only Nobel Prize winner in her department). Although her accomplishments were recognized by the Nobel committee at the end of her career, it is clear that they were not recognized by appointment or pay by her department or her university throughout her career. With such lack of recognition of women in STEM fields it may not be surprising that fewer women go into these fields.

The National Center for Education Statistics reports that women receive only thirty-five percent of the STEM baccalaureate degrees (National Center for Education Statistics, 2017) and hold only twenty-six percent of jobs in STEM fields (Landivar, 2013). Why do women remain underrepresented in STEM? Although societal stereotypes and conventional wisdom suggest that the dearth of women in STEM fields is caused by a lack of ability, an overwhelming amount of evidence suggests that women are just as capable of succeeding in STEM as their male counterparts. Research suggests that gender disparities in STEM are in fact due to social barriers that deter women from pursuing STEM careers.

Throughout grade K-12 girls out preform boys in nearly every subject, including math and science (Else-Quest, Hyde & Linn, 2010). Indeed, one recent meta-analysis examined gender differences in math achievement among 14-16 year olds across 69 different countries. In nearly every analysis, girls and boys performed equally well in math assessments. The gender differences that did emerge were explained by broader forms of societal gender inequality including underrepresentation of women in research and government positions. These results are consistent with numerous other studies showing no gender difference in math achievement.

On high-stakes math and science tests (e.g., math SAT, science reasoning ACT), however, boys earn slightly higher scores than girls (Buddin, 2014; College Board, 2013; Fryer & Levitt, 2010). Why do girls often outperform boys in courses but sometimes perform worse than boys on tests? Research has shown that the main reason that girls perform worse than boys in high stakes testing situations is that negative stereotypes about girls' math abilities become more salient in these situations and lead girls to perform below their potential (Spencer et al., 1999). Indeed, college admissions tests underestimate the future performance of girls and overestimate the future performance of boys (Fischer, Schult, & Hell, 2013; Spelke, 2005; Walton & Spencer, 2009).Taken together, these analyses reveal little evidence for boys being better at mathematics than girls.

Given that men and women are equally capable in math and science, why do women remain underrepresented in STEM fields in college and beyond? Research suggests that women opt out of STEM degrees and occupations because they experience a "chilly climate" in STEM fields (Cheryan et al., 2009). This "chilly climate" is characterized by explicit and implicit gender bias, negative stereotypes, and a variety of subtle cues and messages that make women feel unwelcome and unworthy in STEM. In other words, it's "death by a thousand cuts," which is how Reddit CEO Ellen Pao, in a major sex-discrimination lawsuit against her former employer, described it in an interview with Katie Couric last week. "You're just constantly trying to get this equal playing field, but being taken out of it step by step," Pao explained.

If and when women do decide to go into STEM fields, there continues to be an imbalance in which sub-fields they enter. For example, women are much more underrepresented in robotics, mechanical, electrical, and computer science engineering than chemical and biomedical engineering, (Cheryan, Ziegler, Montoya, & Jiang, 2017). Research has shown that gender disparities are more pronounced in these fields because they tend to have more "masculine" cultures that decrease women's sense of belonging. Cross-cultural analyses examined the presence of such masculine cultures and the distribution of women in these STEM sub-fields in countries like Malaysia. Compared to the US, the "masculine" STEM culture was less pronounced in STEM subfields and was associated with a greater portion of women in those field than in the US.

Additionally, cross-cultural research has found that women in less democratic and economically developed societies such as Jordan, Qatar, and the United Arab Emirates, are actually more represented in STEM compared to democratic western countries such as the United States, Sweden, and Norway (Khazan 2018). One explanation for this surprising finding is that stereotypes about women pursuing higher education in Middle Eastern countries discourage all forms of study, whereas stereotypes in Western democracies specifically discourage women studying STEM disciplines. If these stereotypes are a significant barrier to women's pursuit of higher education then we should see less women in higher education across most disciplines in Middle Eastern countries, but women systematically underrepresented in STEM fields in Western democracy and that is exactly the patterns of study.

When the social barriers that undermine women's interest and performance in STEM are removed, they often perform as well as or better than their male counterparts. For instance, in one study by Stanford University Professor Dr. Gregory Walton, an intervention to mitigate the 'chilly climate' for women in STEM led to a significant increase in grade-point average among female undergraduates majoring in STEM, eliminating the gender gap in STEM achievement (Walton et al., 2015).

Overall, the evidence is clear: although a number of social barriers have deterred women from STEM fields, women and men are equally capable of succeeding in STEM.

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Stoet, G., & Geary, D.C. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. *Psychological Science,* 29(4), 581-593 https://doi.orf/10.1177/0956797617741719

Walton, G.M., Logel, C., Peach, J.M., Spencer, S.J., & Zanna, M.P. (2015). Two brief interventions to mitigate a "chilly climate" transform women's experience, relationships, and achievement in engineering. *Journal of Educational Psychology*, 107(2), 468-485. https://doi.org/10.1037/a0037461.supp (Supplemental)

APPENDIX B

Article Perception

Please answer the following questions about the scientific article you just read.

1. In your opinion, how reasonable in the author of the article?
2. In your opinion, how informed is the author of the article?
3. How compelling did you find the evidence in the article?
4. How valid was the research described in the article?
5. How scientific was the research described in the article?
6. Overall, how much did you agree with the man points of the article?

   Answers: not at all, slightly, moderately, very, extremely

Stereotype Endorsement

Please rate the extent to which you agree with the following statements.

1. According to my own personal beliefs, I general expect men to do better in math than women.
2. According to my own personal beliefs, I general expect men to do better in science than women.
3. According to my own personal beliefs, I generally expect men to do better in engineering than women.

   Answers: strongly disagree, disagree, somewhat disagree, neither disagree nor agree, somewhat agree, agree, strongly agree

Ambivalent Sexism

Please rate the extent to which you agree with the following statements.

1. Many female STEM classmates are actually seeking special favors, such as scholarship or co-op jobs that favor them over male classmates under the guise of asking for "equality."
2. Female STEM classmates are too easily offended
3. Most female STEM classmates fail to fully appreciate all that male classmates do for them.
4. Female STEM classmates seek to gain power by getting control over men.
5. Female STEM classmates exaggerate problems they have in school.
6. When female STEM classmates lost to male classmates in a fair competition, they typically complain about being discriminated against.
7. Female STEM classmates, compared to male classmates, tend to be more pure and moral than men.

8. Female STEM classmates, as compared to male classmates, tend to have a more refined sense of culture and good taste.
9. I enjoy having female classmates in my STEM classes because they make the classroom nicer to look at
10. I would like there to be more female classmates in my program because that would open up more dating possibilities
11. In order to do well in STEM, female classmates need extra academic support compared to men.
12. Male STEM students should go out of their way to help their female classmates with course work.

    Answers: strongly disagree, disagree, somewhat disagree, neither disagree nor agree, somewhat agree, agree, strongly agree

APPENDIX C

Figures

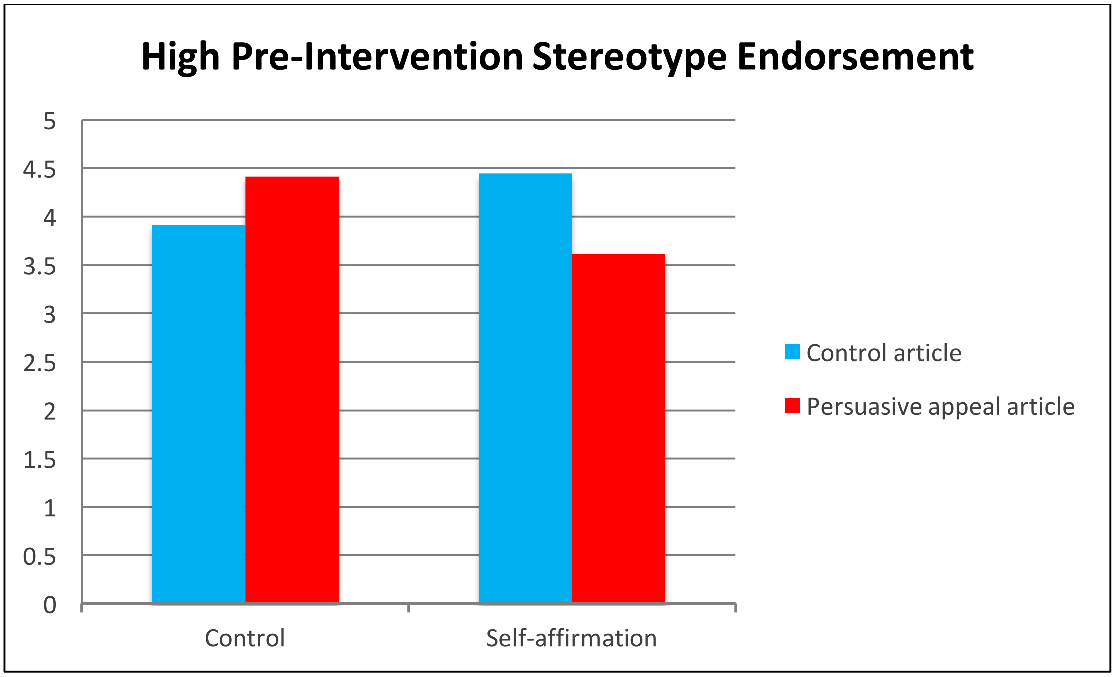

Figure 1. Effects of self-affirmation and persuasive appeal on post-intervention stereotype endorsement. High pre-intervention stereotype endorsement group

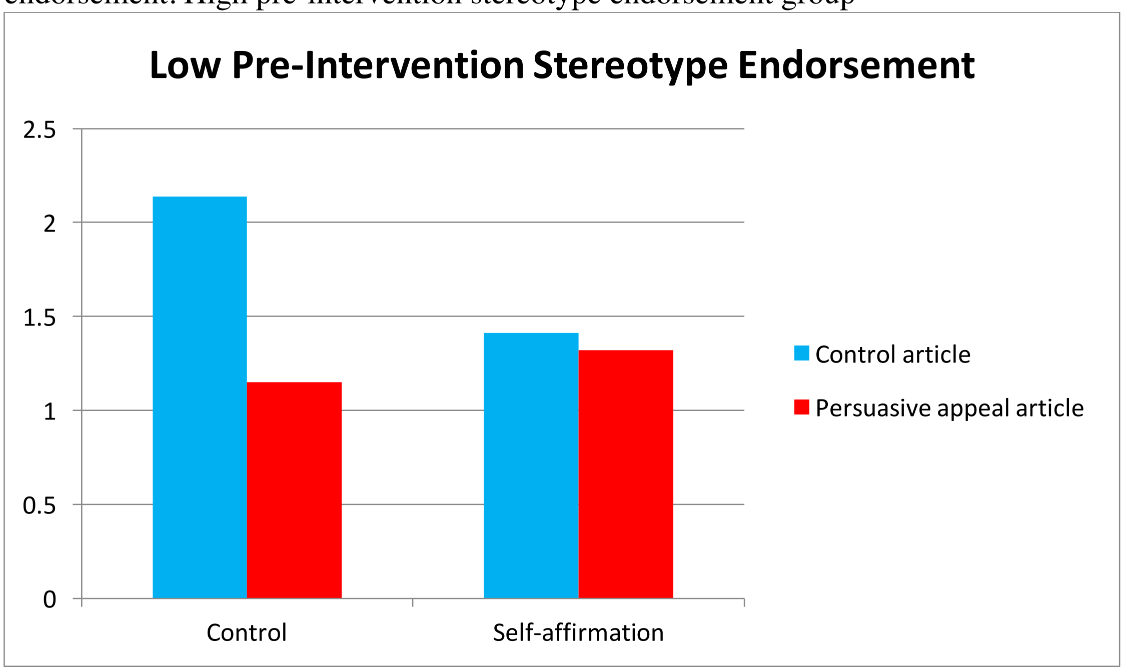

Figure 2. Effects of self-affirmation and persuasive appeal on post-intervention stereotype endorsement. Low pre-intervention stereotype endorsement group